AN UNIFICATION OF THE INTERACTIONS AND THE DIFFRACTIVE PROCESSES

Kuchin I.A.

High Energy Physics Institute
Academy of Sciences of Kazakh SSR,
480082, Alma-Ata, USSR

Abstract. The transition of a number of hadronic process characteristics to a certain universal regime is interpreted as an indication to the early origination of the unification regime of the interactions.

I. Introduction.

Correspondingly to the rapprochement of the electroweak and strong interaction constants in grand unification (GU) models, one can expect a partial loss of the specific character of the mentioned interactions and the transition of their globbal characteristics to some general regime [I].

Though one expect GU coming at superhigh energies (10^{16} GeV according to proton decay), nevertheless the various GU models have been approbated and conformed really at $E_0 \lesssim 10^5$GeV. On the whole, it is the argumentation on the particle spectroscopy and SU(5)-symmetry confirmation level.

If evidences of such sort really bear a relation to GU, then in the same energy region ($E_0 \leq 10^5$GeV) it is logical to expect the GU manifestation on the dynamical level too, that is in particle scattering characteristics. Below we shall show a possible GU-manifestation in the attainable now energy interval.

2. Two sources, two forms of the unification of the particle interactions.

As it is known, the local gauge-invariant principle defines the form of all interactions, irrespective of their physical nature, and gives a theory such a form that it permits the purely geometrical interpretation of the scattering process. Namely, one bring the arbitrary gauge field into correspondence with a definite geometry of the fiber space, which may be received from the usual space-time by the replacement of its points with an "internal" spaces, where the gauge group acts [2].

At very short space-time intervals ($\sim 10^{-4} \div 10^{-3}$fm) the scattering picture reduces to the following: structurless particles (leptons and quarks) exchange by massive vector bosons, and the values of coupling "constants", which depend on the transfer of the 4-momentum, come close (by magnitudes) as the energy increases, so that the strong interactions are weakened while a weak interaction and an electromagnetic one become stronger. If the universality of the interactions means the presence of one general coup-

ling constant, then the unification of the interactions may take place, as it is expected, at the energies of the order of 10^{14}-10^{16}GeV, when it is necessary to take into account gravitation too.

On the other hand, right now (at FNAL- and ISR-energies) we are witnesses of the transition of a number of hadronic characteristics (the total cross-sections, the parameters of the diffractive cone for different pairs of the colliding particles) to a certain universal regime (Fig.I). This phenomenon is known to be caused by the diffraction predominance[4].

The contribution of the diffractive channel of the scattering does not depend on the nature of the colliding particles. To describe the diffraction the only quantum-mechanical(wave) properties of the scattering, some extent of the dynamical symmetry and the unitarity are essentially necessary. All these are discriminating features of some universal mechanism of the interaction.

Thus we may point out two sources (and two forms) of the unification of the interactions:the first comes from the processes at very short distances (for pointlike, structurless particles), the other- from a processes at comparatively large distances (~I÷2 fm), in soft interactions of the extensive objects.

3. The principle connection between the diffraction and gauge fields.

There is no satisfactory theory of diffractive high energy scattering of particles at present. In particular, it should be cleared up what "the internal spaces" are responsible for the gauge-invariance principle for the diffractive processes. Nevertheless, a principle connection between the diffraction and the Yang-Mills-type fields exists. It is traced e.g. in that line, which connects non-Abelian gauge theories and the Weyl's geometrical electrodynamics and a string-type solution of nonlinear equations[2]. After all, in the particle physics the string represents the neutral gluonic field - the carrier of the diffractive properties of the interactions on quark-parton level.

4. The predominance of the diffraction in hadronic interactions at high energies.

So one can think, that the more profound general understanding of the particle diffraction will lead to an essential expansion of the area of the diffractive phenomena, though even now their contribution to the total cross-section, by no means, is not small. According to special analysis[4](the author makes use of the theoretical understanding of the diffraction in gauge theories (in RQT) and of the conception of the pomeron in QCD) in the FNAL -ISR energy interval, the contribution of the diffraction interactions is not less than 95 per cent from σ_{tot} up. The role

*) It is worth notice a tendency to growth of the total σp-interaction cross-section in the region of $E_0 \geq$ I00-200GeV (see ref. on the data in [3]).

of diffraction seems to be so large, that one may speak about true "regeneration" of the strong interactions in the $E_0 \gtrsim$ IO GeV region.

Since the universal properties of the scattering, which act in the diffraction, are important even for GU theory, then all these properties (and, together with them, the diffraction too) work up to complete strengthening of the GU regime. Therefore, there is no reason to expect the decrease of the diffractive contribution when passing to the region of higher energies. On the contrary, it should be expected the increase of its role, because the total unification of the interactions assumes the confluence of its two forms into one.

5. Conclusion. Taking into account that due to a large value of the coupling constant the strong interactions earlier than the others reach a large value of the cross-section and approach GU regime "from above" (whereas the electroweak interactions approach it "from below"), one may conclude, that the observed transition of a number of hadronic process characteristics to certain universal regimes (Fig.I) is the early evidence of the unification regime, in which strong interactions enter.

6. Proposal for cosmic ray investigators.

The interval from the energies of the electroweak unification ($\sim IO^5$GeV) to the grand synthesis ($\sim IO^{16}$GeV) is vast. Here one may expect for manifesting of quite new physics. We should remind that up to now any increase of the energy by several orders results in discovery of a new class of the phenomena. The possibility of the phenomenological generalization of the canonical commutation relations for processes at very high energies has been already discussed elsewhere.

For example, it is proved that such modification of the quantum mechanics becomes important at the energies which are typical for GU scheme ($\sim IO^{16}$GeV) [5]. The other possibilities may appear in the course of more profound understanding both the phenomenon of the diffraction and the mechanism of the unification of the interactions.

A considerable part of the foregoing energy interval of the saturation of the GU regime is available for the cosmic ray particle experiments (up to $E_0 \gtrsim IO^{11}$GeV) [6]. Due to specific conditions of cosmic ray experiments (limited statistics, high registration thresholds of interaction products) practically only inelastic diffraction of incident hadrons and nuclei is observed in these experiments [7]. This allows to study the process of unification just in the experiments with cosmic ray particles.

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Figure I.

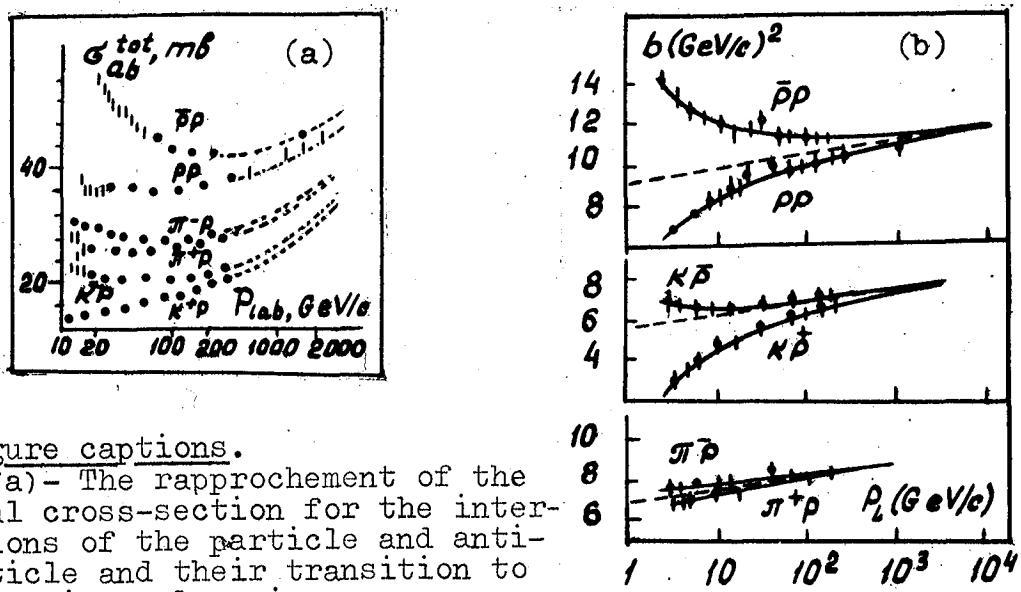

Figure captions.

(a)- The rapprochement of the total cross-section for the interactions of the particle and anti-particle and their transition to some universal regime.

(b)- The same for the slope parameters of the elastic scattering $b^{el}_{ab}(s)$.